

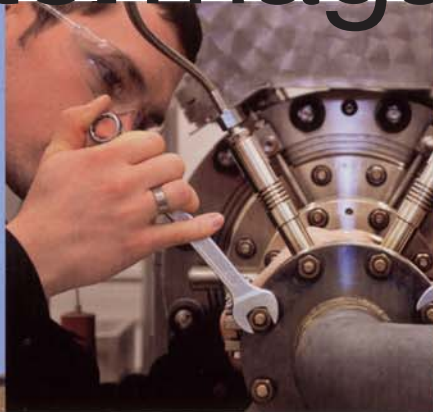


BOOSTING THE FUTURE

**Redefining Performance  
Through Technology**

**Honeywell**

# booster magazine



## On Track

- + With Europe emerging as the center of gravity for the commercial vehicle segment, Honeywell is transforming its support to commercial vehicle OEMs with the opening in the Czech Republic of one of the world's most advanced engineering and test facilities.
- + It delivers the performance of a two stage turbo system in a single package – no wonder Honeywell's Single Sequential Turbo is being heralded as a major breakthrough in helping truck OEMs develop diesel power plants capable of meeting the next round of emissions standards.
- + 2011 marks the introduction of US Non-Road Tier 4 emissions regulations for off-highway engines. The new standards will require a 90 percent reduction in particulate matter and 85 percent lower levels of NOx compared to current limits...and that will likely mean the industry-wide adoption of variable geometry turbocharging.
- + It's almost 20 years since Honeywell developed and installed the world's first Variable Nozzle Turbine (VNT™) turbocharger in Nissan Diesel's 12.6-liter engine for heavy-duty trucks – and the concept remains the preferred architecture for this sector, with evolutionary design improvements continuing to deliver ever more impressive performance levels.
- + Two of the world's leading automotive brands are redefining the relationship between power, fuel economy and CO<sub>2</sub> output in gasoline passenger cars. BMW took center stage at the Geneva Motor Show with its remarkable V8 X6 xDrive50i – the world's first Sports Activity Coupe – while Ford is winning plaudits in the U.S. for its revolutionary range of EcoBoost engines.

4 **GLOBAL RESOURCES, LOCAL COMMITMENT**  
Enhanced worldwide support for commercial vehicle customers

6 **ACCELERATING CREATIVITY**  
Honeywell transforms its global R&D capabilities

8 **ENGINEERING THE FUTURE**  
Brno - where technical excellence comes as standard

10 **SINGLE TURBO REVOLUTION**  
Breakthrough design sets new performance benchmark

12 **OFF-ROAD RACE TO FUEL EFFICIENCY**  
OEMs look to variable geometry turbos for emissions control

14 **THE FUTURE OF DOUBLE AXLE VNT™**  
Design evolution extends technology leadership

16 **GENETIC BREAKTHROUGH**  
Twin gasoline turbos provide the 'X' factor for BMW

18 **DOWNSIZING THE U.S. WITH ECOBOOST**  
Ford's new turbo gas engine fuses power and fuel efficiency

20 **THE "YUCHAI PHENOMENON"**  
Chinese engine maker rides remarkable growth curve

22 **MEDIA TALK**  
The latest news and views from around the world

**Imprint:** Honeywell Booster Magazine  
**Chief Editor:** Michelle Dumétier, +33 (0)1 55 46 22 21, michelle.dumetier@honeywell.com  
**Deputy Editor:** Chen Yao, chen.yao@honeywell.com  
**Photos:** BMW, Caterpillar, Ford Motor Company, Hino Trucks, Honeywell, Isuzu Motors, Kenworth Truck Company, Peterbilt Motors Company, Scania, Yuchai Machinery

© 2008 Honeywell International Inc.

All trademark names mentioned herein, with the exception of Honeywell and Garrett®, are for reference purpose only and are not intended to suggest any connection between Honeywell International Inc. and the companies who own them.





# Listening and Learning

Dear Readers:

At Honeywell Turbo Technologies, we are proud of our reputation as the technology leader that has partnered with major car and truck makers for more than 50 years.

Being the leader means being an expert at many things, from aerodynamics to materials sciences to strategic planning on a global scale. But fundamentally, it is about anticipating and solving future challenges – be they from customers, regulators or drivers.

To enhance this capability, our global lab and test services are undergoing a transformation. We are increasing our capabilities from the U.S. to France, from China to UK, and from Japan to Korea, with our next addition in India – to better cater to the needs of the expanding automotive industry there.

Worthy of special note is our new technology center in Brno, Czech Republic. Equipped with state-of-the-art engine cells, gas stands and the world's most advanced analytical hardware and software, the Brno Center will emerge as a key hub in our global network by 2009. This serves as a further testament to our long-term commitment to better serve passenger car and truck OEMs.

From a technology perspective, our commercial vehicle customers can look forward to the benefits associated with the breakthrough Single Sequential Turbo and the latest evolution of our patented Double Axle VNT™ technology. And in passenger vehicles, our gasoline boosting technologies are making their mark with Ford's EcoBoost engine and BMW's X6, a harbinger of many new launches to come.

This forward thinking is delivering the benefits of a more robust portfolio of technologies. Most important, our enhanced global R&D network, coupled with a talented and experienced dedicated engineering team, is driving us to even better serve our global customers. We feel the future is bright for the energy efficient technologies and solutions that we provide. So, we're getting set for that future...and the time to invest in it is now.

*Adriane M. Brown*

Adriane Brown  
President and CEO  
Honeywell Transportation Systems



**COVER:**  
The Scania R580 and  
BMW X6 boosted  
by Honeywell turbo  
technologies



- + INNOVATIVE TECHNOLOGIES DELIVER ON EMISSIONS TARGETS
- + HONEYWELL'S WORLDWIDE INVESTMENT PAYS DIVIDENDS

# Global Resources, Local



**Tony Schultz, Vice President of Customer Management for Commercial Vehicles at Honeywell Turbo Technologies, surveys the commercial vehicle landscape and sees a future in which global partnerships will become increasingly important in meeting emissions standards around the world.**

**What are the current major trends in the global commercial vehicle market?**

We are seeing that Europe is emerging as the new center of gravity for the CV business, with major OEMs exploiting the opportunities created by vertical integration. While the U.S. is going through a rough period due to the credit crunch, the CV business is strong in Europe, Asia and South America.

OEMs also have their gaze fixed on incoming emissions standards: US 2010 and then Euro VI for on-road and US Tier 4 for off-highway. While these regulations undoubtedly present technical challenges for truck manufacturers and their partners, they also represent significant growth opportunities through technology upgrades.



# Commitment

## **How is Honeywell positioned to respond to these challenges?**

We are strongly positioned – our technology portfolio is achieving notable successes in awarded engine programs. In addition, our global investment strategies in manufacturing and in research and development facilities create major advantages for customers. Our new engineering and test center in Brno, Czech Republic, demonstrates the success of this strategy.

When fully functional, Brno, along with Torrance and Shanghai, will be one of the most advanced turbo development and test facilities in the world for our business. Regionally, the center will provide a significant increase in application engineering capability, along with prototyping and testing...all in close proximity to our customers based in Europe.

I also believe that we are now viewed as a truly global partner to the CV OEMs. With a dedicated worldwide CV team headquartered in Switzerland and strong on-the-ground support, we are globalizing our business and developing consistent strategies and processes from a project and customer standpoint.

## **What are the Honeywell priorities in terms of technology going forward?**

There are some very exciting new technologies, such as the Single Sequential Turbocharger, which delivers the performance of two turbos in a single package, in series sequential technology and in the evolution of our market leading Double Axle VNT™ product range. For off-highway, the big new technology is a Double Axle VNT™ turbo with electro-hydraulic actuation.

In addition to these new advances, we are also determined to add value by working much more closely with customers at the outset of projects.

## **What about the prospects for the future?**

I am very optimistic about our prospects going forward as we support our customers in the run up to Euro VI and US 2010. We are also well positioned in terms of our technology portfolio for incoming standards in India and China, with the likely move from wastegated products to variable geometry turbo solutions.

Technology is clearly driving growth but our global structural changes are also providing a much clearer customer focus. I believe that we are increasingly looked upon as a company making a real global contribution to the commercial vehicle industry with a strong local touch.



## **Cleaner Trucks in the U.S.**

Thanks to more than a decade of mandates from the US Environmental Protection Agency (EPA), new truck engines have been getting cleaner and more fuel efficient.

The 2007 engines have virtually eliminated the black sooty smoke associated with diesel engines because they have big particulate filters that reduce particulate emissions to almost zero.

And compared to engines made before 2002, they release about 80 percent less nitrogen oxide, which contributes to smog. In addition, the ultra-low sulfur diesel fuel that has been available since October 2006 further reduces pollutants contributing to smog.

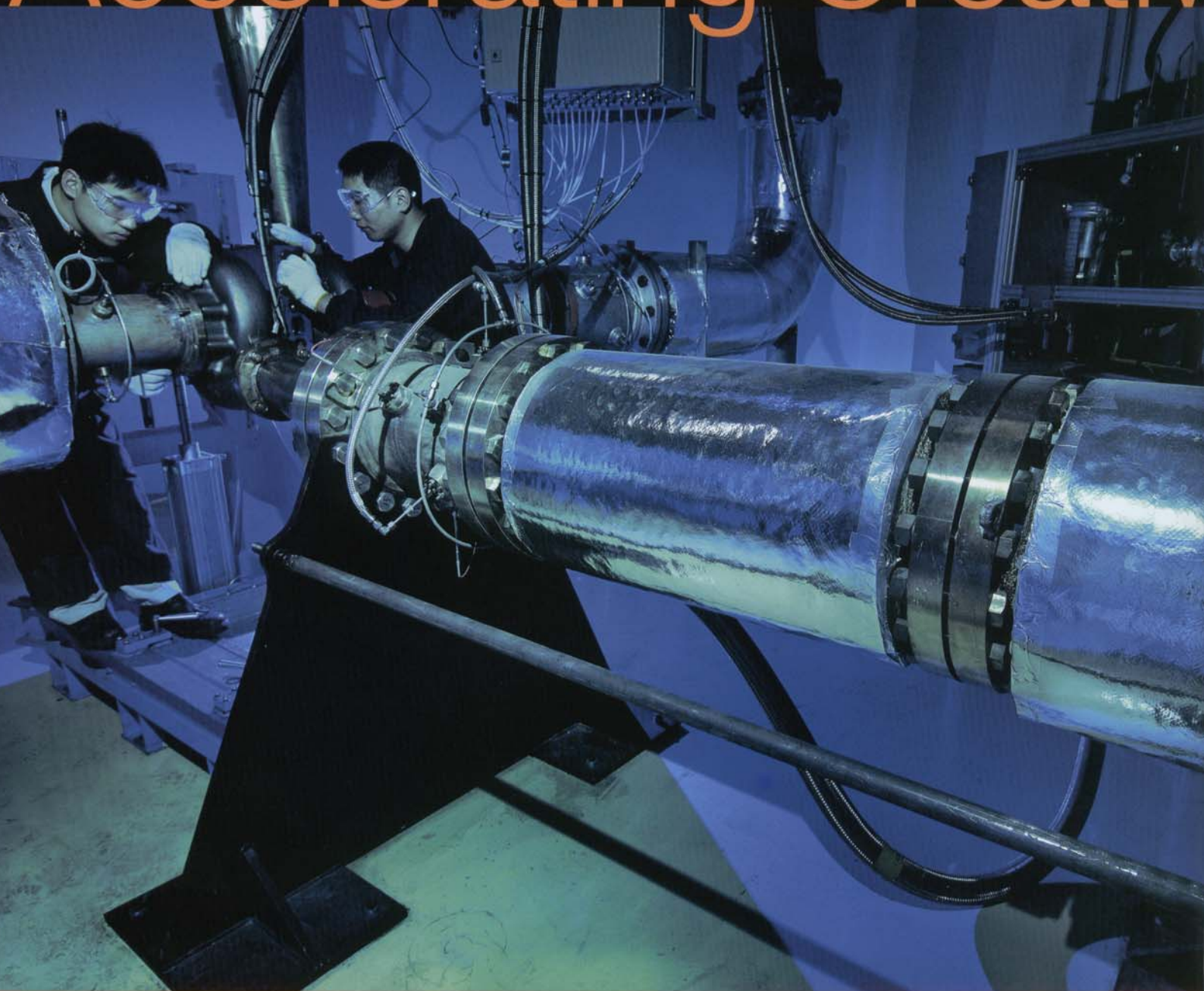
With about 3 million trucks on the road, most engines today are pre-2007, says the American Trucking Associations. Given that about 200,000 new truck engines are sold each year, EPA says it likely will take until 2030 for all the trucks on the road to have the "green" engines.

*Source: Arizona Republic*



- + HONEYWELL TRANSFORMS ITS R&D LABORATORY NETWORK
- + BRNO CENTER ADDS TO GLOBAL FOOTPRINT

# Accelerating Creativity



**It's the network that turns bright ideas into breakthrough innovations in turbo design. Now the global Honeywell laboratory and test service that dedicates hundreds of thousands of hours every year to customer projects is itself undergoing a transformation.**

New equipment, new people and new centers of excellence are being added to the R&D network to ensure that this world class resource is truly global in its reach. Karl-Heinz Bauer, Chief Technology Officer of Honeywell Turbo Technologies, is leading the change program and says that the transformation will ensure closer alignment between the laboratory service and the requirements of OEMs.



The direct beneficiaries include commercial vehicle manufacturers headquartered in Europe, who will receive support from a newly built state-of-the-art center in Brno in the Czech Republic. The Brno center will become a key element in a Honeywell laboratory network that stretches from the U.S. to France, from China to UK, and from Japan to Korea...and there are also plans to develop leading edge technical facilities close to the fast growing car industry in India.

Comments Karl-Heinz: "The automotive industry is dominated by global businesses...but these manufacturers need support right around the world, close to their plants and technology centers in order to meet different regional priorities. So this investment is about ensuring that we enable the best talent to use the best equipment available in locations that best suit the needs of our customers. Increasingly this includes providing support in emerging regions."

Honeywell's global facilities are staffed by more than 1200 of the world's most experienced and talented turbo engineers, who share resources around the world to work on behalf of customers 24 hours a day, seven days a week.

"A key element in this transformation is ensuring that we invest in the most advanced diagnostic and analytical tools, which self-evidently are the building blocks of data acquisition and testing," says Karl-Heinz.

"We are now using highly sophisticated computer modelling and simulation to enhance test performance, but we should always remember that it is human intellect that invents and then applies winning technologies...and we've got some of the best turbo brains in the world."

Honeywell's expansion of its laboratory network is indicative of the company's determination to enhance product analysis and testing know-how in order to shorten the time it takes to design and develop products.

"The spreading of our global R&D footprint is augmented by new systems and processes that enable our engineers to share knowledge and to collaborate irrespective of where they are based," says Karl-Heinz. "The recently established Honeywell Learning Curriculum is proving to be an invaluable resource for sharing analytical data while at the same time enabling our engineers to learn from each others' hands-on experiences. This knowledge transfer is a vital tool in providing the application engineering support required by our customers – and to creating the breakthrough turbo technologies of the future."

### The Global Network of Honeywell Engineering Centers

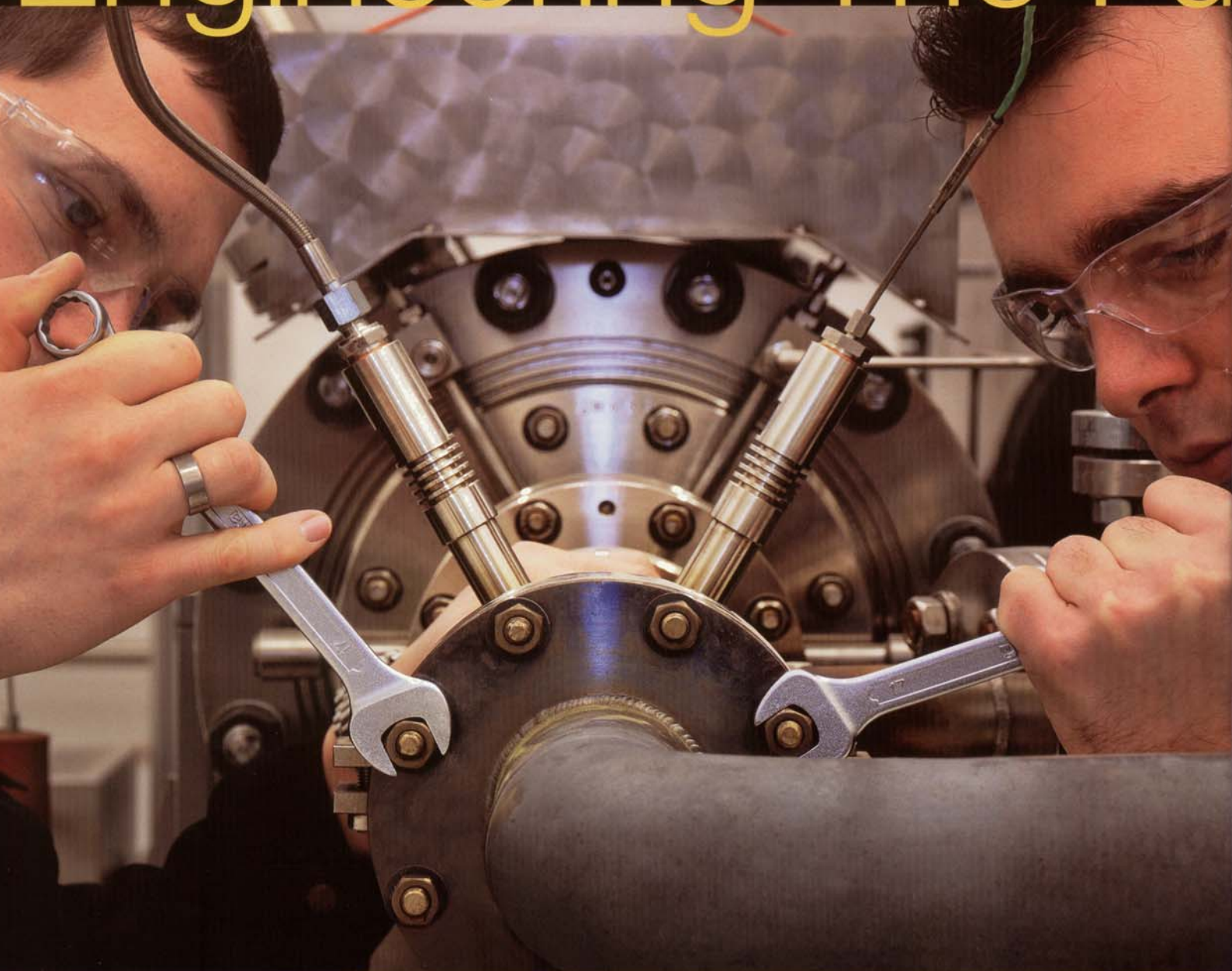
1. Torrance, CA, USA
2. Skelmersdale, UK
3. Thaon-les-Vosges, France
4. Brno, Czech Republic
5. India (opening soon)
6. Shanghai, China
7. Korea (opening soon)
8. Kodama, Japan





- + HONEYWELL UNVEILS THE BEST IN BRNO
- + BIGGEST EVER INVESTMENT IN COMMERCIAL VEHICLE SUPPORT

# Engineering The Fu



## Honeywell Global Design Center in Brno

At the Global Design Center in Brno, which is an integral arm of Honeywell Technology Solutions Lab (HTS), Honeywell businesses collaborate through research and development with the company's global network of centers to provide support to customers around the world.

The Design Center was established in January 2003 and benefits from Brno's industrial legacy of advanced technology covering electronics, precision engineering and optics. The area has witnessed the dynamic growth of technical universities and the availability of high skilled engineers. A key element in locating in the region is the significant economic and investment potential.



# ture

A new model in engineering support will be unveiled by Honeywell when its Turbo Technology Center in Brno in the Czech Republic is formally opened in May 2008.

Honeywell's \$17 million addition to its global laboratory network is a combination of the most advanced test and engineering equipment and some of the brightest talent available. Brno is being developed to meet the rapidly growing global demand for sophisticated turbocharging systems – but what's particularly innovative about Brno is the structure of support being made available to automotive customers.

The facility will see the creation of fully integrated, high performance teams that combine the technical skills of 250 leading experts and the full range of Honeywell engineering capabilities under one roof. It is a seamless approach to developing and applying the turbo technologies that will help meet the emissions and performance requirements of the world's leading automotive manufacturers.

"The aim of cross-functional support is to drive up engineering quality still further while compressing the time it takes to move from turbo concept to application," says Servet Sert, who leads Honeywell Turbo's Technology Center at Brno.

Development work started at Brno in 2005, when Honeywell took the strategic decision to expand its global technical capacity, particularly for the commercial vehicle segment. Brno, which is also home to technology labs for other Honeywell businesses including aerospace, boasts a ready supply of highly skilled engineers. Its geographical

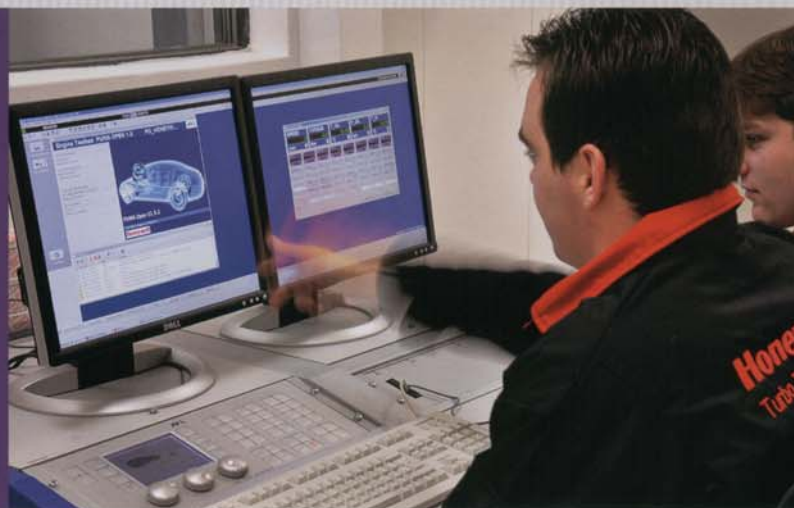
location positions the business, quite literally, within easy reach of some of the biggest automotive OEMs in the world.

The ramp up of people and equipment has been intensive but it means that by 2009, the facility at Brno will be a major engineering center in Honeywell Turbo's global network. It also represents the biggest investment ever made by Honeywell on behalf of its growing customer base of commercial vehicle manufacturers, with 40 percent of the center's capacity given over to commercial vehicle turbo support.

The technical center boasts 15 engine cells and 7 gas stands as well as the most advanced analytical hardware and software available anywhere in the world. The facilities will enable Honeywell engineers to collaborate with customer teams to optimize margins of performance in aerodynamics, rotordynamics, materials engineering and mechanical analysis.

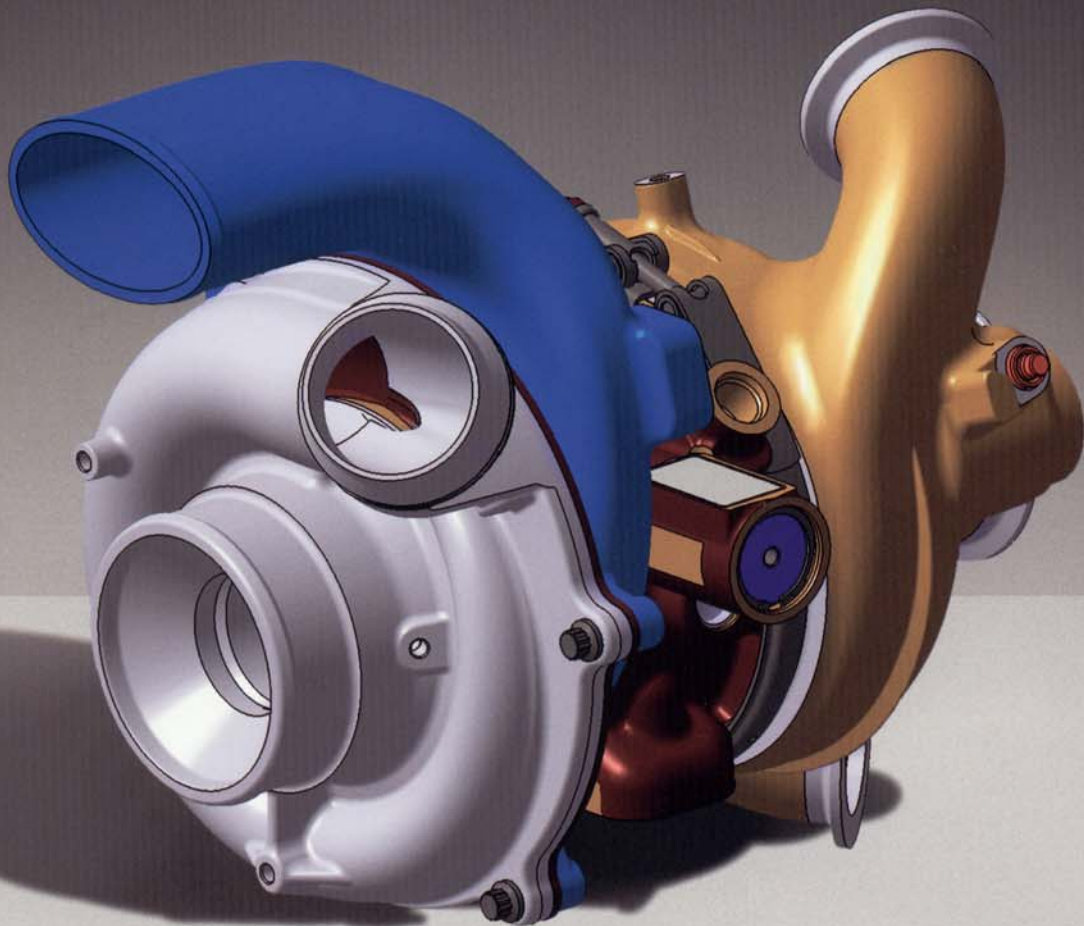
"We have focused particularly on recruiting high caliber engineers and have provided more than 4,000 man days of training to turn the concept of integrated teamwork into reality," says Servet. "We now have design and simulation engineers sitting alongside platform engineers and application engineers – the effect is that we are able to deliver the ultimate benefit of our technologies to our customers at the earliest possible phase of each program."

Since January 2005, the Global Design Center has integrated into the corporate Honeywell Technology Solutions Lab as HTS-Brno organization.





# Single Turbo Revolu



## SST: The Perfect Match

As turbocharged diesel engines have evolved to higher BMEP (brake mean effective pressure) levels, and with ultra-low levels of regulated emissions, it has become increasingly difficult to match the turbine and compressor in a conventional turbocharger while still achieving the desired level of performance and responsiveness.

Emissions regulations demand the use of ultra-high levels of Exhaust Gas Recirculation (EGR) to control NOx and Diesel Particulate Filters (DPF) for lower soot and particulate emissions. These technologies

exacerbate the compressor/turbine matching issue by reducing the turbine corrected flow to as little as half the compressor corrected flow.

Honeywell's Single Sequential Turbo technology significantly improves the performance of the turbine by changing the work/speed relationship of the compressor. This is accomplished by using a double-sided compressor that can operate to the pressure ratios required to drive ultra-high levels of EGR consistent with US 2010 emissions.



# tion

Engineers at Honeywell have developed a unique way of delivering two-stage performance levels within a single turbocharger package for light truck applications.

The Single Sequential Turbo (SST) is being heralded as a breakthrough, ranking alongside Variable Nozzle Turbine (VNT™) and AVNT™ technologies – and in the not so distant future its full effect will be witnessed on highways across the the U.S. and beyond.

SST is setting new benchmarks by harnessing the power of two compressors and one turbine in a single housing for the first time ever, so creating performance levels only previously made possible by dual-stage engine boosting systems.

"This is a world first – and a development that truly deserves to be called an industry breakthrough," says Steve Arnold, Head of Honeywell's Innovation Group.

In developing SST, Honeywell engineers have succeeded in overcoming one of the most fundamental issues impacting turbo performance – the negative effect on compressor/turbine flow of the ultra high levels of Exhaust Gas Recirculation required by modern diesel engines to control NOx.

In a conventional turbo, this mismatch makes it difficult for the turbo to meet the demand of the engine for air and to pump EGR efficiently while still providing good transient response.

Multi-turbo systems can overcome these issues but can also face problems related to packaging and under-hood heat rejection.

The SST addresses all these challenges in a single revolutionary, holistic design by incorporating a dual compressor wheel that works 'back-to-back' in a single casing. Combined with the patented ball bearing cartridge, this leads to an impressive double digit turbine efficiency improvement.

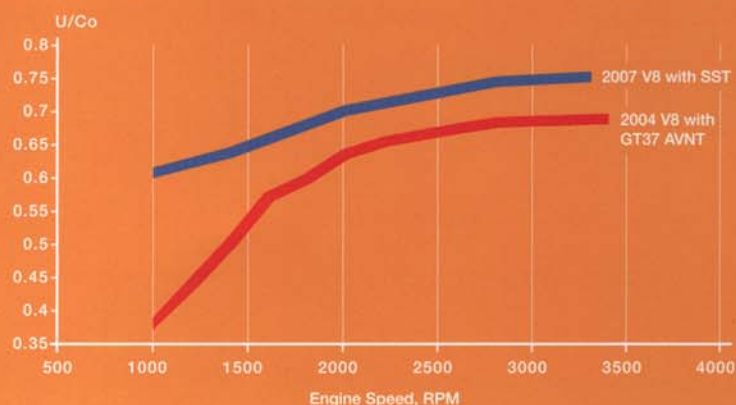
"This is a key turbo development for CV OEMs as they seek solutions to provide better fuel efficiency, enhanced driveability and improved emissions control," says Steve. "SST will become a critical turbo technology for the next five years as OEMs develop commercial vehicle diesel power plants capable of meeting the next round of emissions standards."

"Breakthrough can be something of an overused term," says Steve, "but in the case of SST, the technology is without question a world first of major significance as OEMs focus on commercial vehicle engine programs for 2010 and beyond."

When combined with a ball bearing cartridge, this concept results in a single turbo with significant turbine efficiency gains that drive performance unattainable in a conventional single turbocharger configuration.

The SST packaging is smaller than a conventional turbocharger, but provides performance closer to sequenced, multi-turbo systems. It also incorporates a very small turbine with low thermal capacitance for improved after-treatment temperature management.

Blade Speed Ratio for SST matched to 2007 V8 Pickup





- + OEMS GET SET FOR NEW EMISSIONS STANDARDS
- + TURBO TECHNOLOGIES MEET THE CHALLENGE

# Off-Road Race To Fuel



**Think of turbocharging and most people will picture a modern passenger car or heavy-duty truck. In fact the heritage of turbo is deeply rooted in off-highway applications, going back all the way to 1955 when the Caterpillar D9 crawler tractor, fitted with Garrett® T15, became the first American production turbo-charged diesel.**

Today, turbocharging is a core technology in a high proportion of the 1.6 million off-road engines produced globally each year – but its role in this segment is about to be transformed.

The year 2011 marks the introduction of US Non-Road Tier 4 emissions regulations for engines that drive an incredibly wide range of industries. The new regulation will eventually demand a 90 percent reduction in particulate matter (PM) and 85 percent lower levels of NOx from current Tier 3 levels. From construction to agriculture, from marine to mining...the race for more fuel efficient and environmentally-friendly off-highway power plants is truly on.



# Efficiency

The new regulations cover all off-road applications, from the smallest 8kW units to monster machines generating over 2.5MW in power. For Honeywell, the initial focus is on meeting the needs of OEM customers in the engine range from 130 – 560kW for model launches planned in 2010.

In practice this means a reduction in particulate matter from 0.2 to 0.02g/bhp-hr and an initial 50 percent reduction in NOx from 4g/bhp-hr to 2g/bhp-hr, reducing by 2g/bhp-hr.

"PM is probably easier to manage through exhaust after-treatment like particulate traps but it is NOx where the real battle ground will be – because NOx emissions result from the temperature of the combustion process and that is much more difficult to manage without sacrificing engine performance and fuel efficiency," says Mark Rodrigues, Off-Highway Platform Manager at Honeywell Turbo Technologies.



So OEMs are focusing on a twin-track approach – looking at both the combustion process, including Clean Gas Induction (CGI) or Exhaust Gas Recirculation (EGR), and exhaust after-treatment, possibly by combining a diesel oxidation catalyst with a particulate

filter or using Selective-Catalytic Reduction (SCR) systems (pioneered on On-Highway applications in Europe).

CGI and EGR work by recirculating a portion of an engine's exhaust gas back to the engine cylinders – and because exhaust gas has a higher specific heat than air, it serves to lower peak combustion temperature, which in turn has a beneficial effect on the level of NOx generated.

Consequently, EGR will likely become a fundamental driver for off-highway OEMs to migrate from current wastegate or free floating turbos to variable nozzle turbine technology (VNT™). VNT™ not only optimizes fuel efficiency, it also enables exhaust gas flow to be varied instantaneously and delivers the exhaust back pressure required for successful EGR.

Says Mark: "Double Axle VNT™ is a proven on-highway technology, so people feel comfortable that this would also be a robust off-road solution for 2011 and beyond, particularly for equipment that requires exhaust braking. We're also working with customers to investigate aligning Double Axle VNT™ with electro-hydraulic actuation to improve packaging and increase robustness to temperature and vibration in what can be extremely harsh working environments."

Add to this growing interest in the latest series turbo developments – in which two compressors are housed in a single turbo package to drive the higher compressor pressure ratios required for EGR systems – and it's clear that Honeywell is ready and able to play its part in keeping the world's off-highway vehicles on the move.



## Clean Air Non-road Diesel - Tier 4

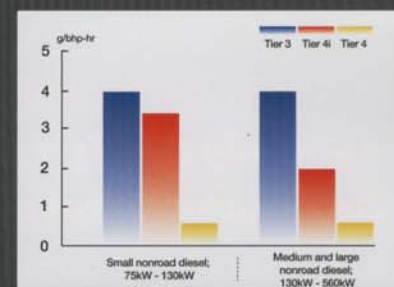
EPA has adopted a comprehensive national program to reduce emissions from future nonroad diesel engines by integrating engine and fuel controls as a system to gain the greatest emissions reductions.

To meet these emissions standards, engine manufacturers will produce new engines with advanced emission-control technologies similar to those already expected for highway trucks and buses. Exhaust gases from these engines will decrease by more than 90 percent. The new standards are also adopting a limit to decrease the allowable level of sulfur in non-road diesel fuel by more than 99 percent.

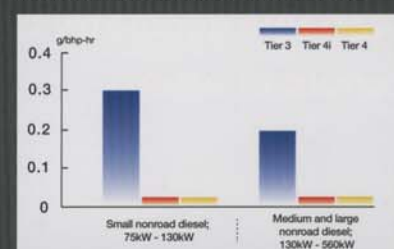
The new rule will result in the widespread introduction of emissions control systems and in a reduction of pollution equivalent to having some two million fewer trucks on the road.

Source: US Environmental Protection Agency

## NOx Emissions



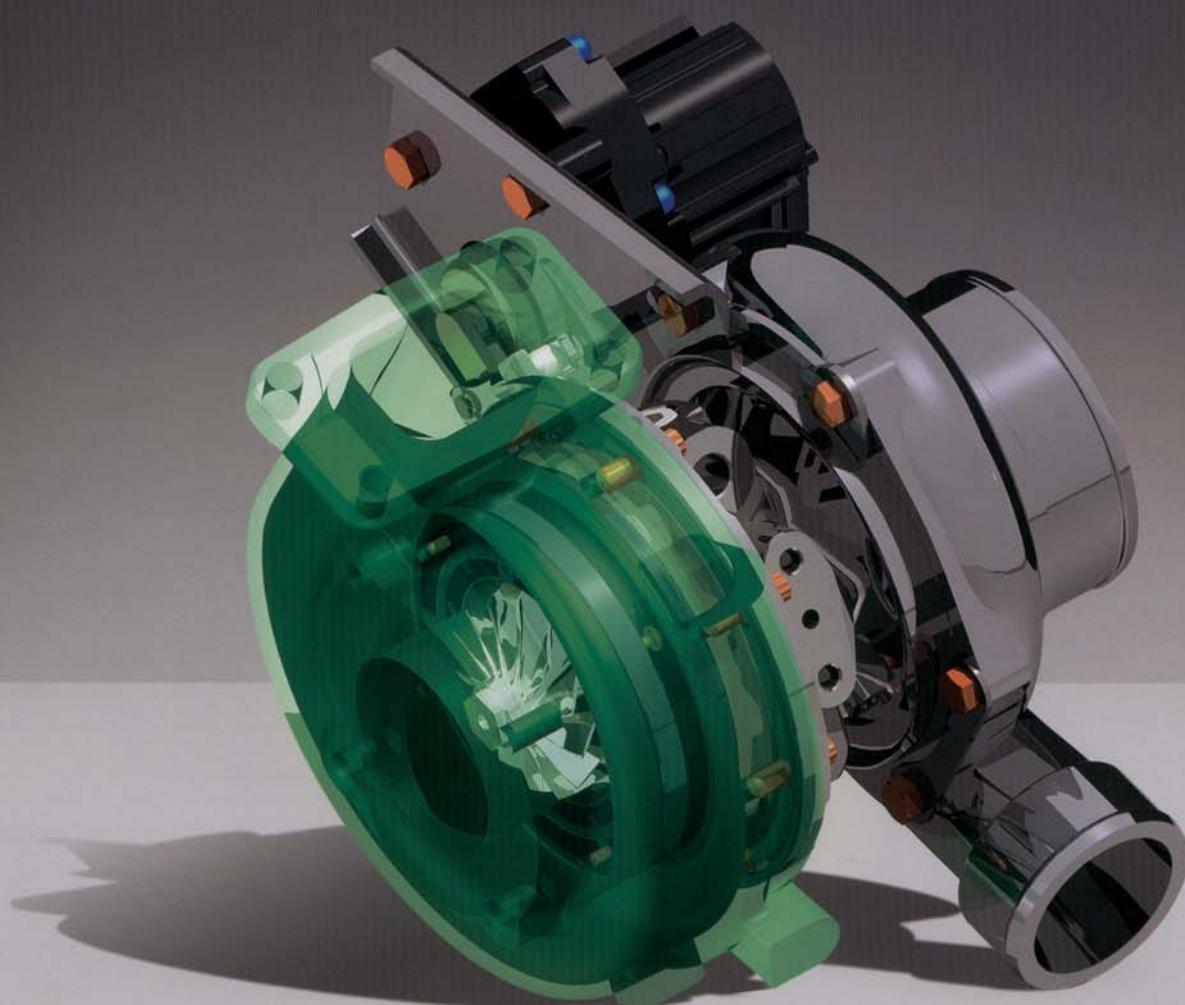
## Particulate Matter Emissions





- + INNOVATIVE VANE DESIGN BOOSTS PERFORMANCE
- + TRUCK OEMs FOCUS ON 2010

# The Future Of Doub



**In 1989, Honeywell helped Nissan Diesel make history when it adopted the world's first VNT™ volume production turbo on its 12.6-liter engine for heavy duty trucks. What's surprising is that the concept of a variable nozzle turbine had actually been developed decades before in the 50s by a Garrett Corporation engineer – but in an era when emissions standards were almost non-existent, variable geometry turbocharging was seen as a luxury item that the truck market could ill afford.**

"Today, of course, it is very different," says Rob Cadle, On-highway Platform Manager at Honeywell Turbo Technologies. "Emissions standards have turned VNT™ from good-to-have technology into a must-have solution."

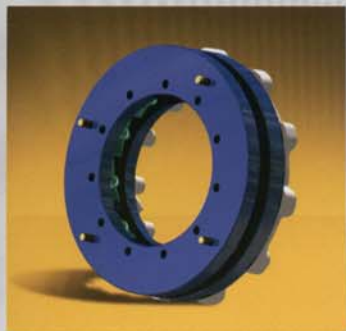


# Double Axle VNT™

It was in 2000 that Honeywell introduced its ground-breaking Double Axle VNT™ technology on DDC Series 50 engines in response to much more stringent NOx requirements and a broad adoption of Exhaust Gas Recirculation (EGR). Specially designed for heavy-duty diesel applications, the GT40V turbo used 15 turbine nozzle vanes that were supported by twin axles, while the patented pressure balancing minimized vane side loading during operation.

This configuration provided a more precise control of EGR flow with minimum fuel efficiency penalty. As EGR has been more widely adopted, more and more manufacturers have implemented Double Axle VNT™ technology.

Since then, Double Axle VNT™ technology has been adopted by major Japanese truck makers and will be launched on heavy-duty trucks by European OEMs in 2008. The robust design of the technology is highlighted by the fact that back in 2004, its B10 reliability achieved 1,000,000 miles plus.



The next major challenge for truck OEMs is US 2010 Emissions Standards, and in response, Honeywell has developed a Double Axle VNT™ product using cambered or curved vanes.

"The cambered vane design allows for more design flexibility so we can tailor the characteristics of throat area

and vane angle for higher performance and reduced disturbance," says Rob Cadle. "With the new cambered vanes and turbine wheels, the turbo speeds can be 30 percent higher with a 4-6 percent improvement in efficiency."

This focus on vanes and the turbine wheel has enabled Honeywell to address the issue of High Cycle Fatigue (HCF) failure, which is the result of constant vibration caused by a pressure wake on blades. As a result of collaboration with their aerospace counterparts, particularly in areas such as aerodynamics and structure sciences, Honeywell turbo engineers are at the forefront of HCF research.

While the current Double Axle VNT™ was designed to meet 2007 US Emissions standards and Euro V, the new cambered vane version is intended for engines that will meet much more stringent US 2010 standards and Euro VI. This new boosting technology is expected to debut on a US application in 2009.

"Honeywell was the first turbocharger company to put a variable geometry turbo into production," says Rob Cadle, "and as a result of our next generation Double Axle VNT™, we remain the technology leader with the highest efficiency, best reliability, and most cost-effective VNT™ product in the world."



## Evolution of VNT™ for Commercial Vehicles

**1951:** Garrett engineer Ted von der Nuell advocated the controlled variable nozzle as best concept for a turbocharged earthmover.

**1989:** Nissan Diesel adopted Garrett® TD 4501 turbo as the world's first VNT™ volume production turbo on its 12.6-liter engine for heavy-duty trucks

**2000:** Garrett® Double Axle VNT™ turbos were introduced on the DDC Series 50 bus engines.

**2001:** Hino introduced Honeywell Double Axle VNT™ technology on its heavy-duty truck engines; International selected Garrett® AVNT™ turbochargers (GT37 and GT40 AVNT™) for its engines that went into International trucks.

**2003:** Honeywell AVNT™ technology was fitted on Duramax engines, which were installed on Chevrolet Silverado, GMC Sierra and GMC Topkick 4500 to 6500 series.

**2005:** Nissan Diesel and Isuzu introduced Double Axle VNT™ technology on their heavy-duty truck engines.

**2008:** Honeywell developed the latest Double Axle VNT™ with cambered vanes.



- + IN A CLASS OF ITS OWN
- + TWIN TURBOS PUSH BMW DESIGN ENVELOPE

# Genetic Breakthrough



The launch of the new BMW X6 xDrive50i created quite a stir at its Geneva Motor Show premiere – and not just because the model heralded the unveiling in Europe of what is being called the very first Sports Activity Coupe. This latest “crossover” vehicle also attracted attention because its V8 engine is rated the most efficient in its class, featuring twin turbos uniquely positioned in the middle of the “Vee.”





The result is stunning – with the all-new 8 cylinder gasoline engine delivering exceptional performance by creating 300kW (407hp) of power and developing 450 lb-ft (610Nm) of torque.

The X6 xDrive50i engine positions the twin Honeywell turbochargers in the “Vee” between the cylinder banks. When coupled with direct injection, this affords cooler intake charge, meaning that higher compression ratios can be used to improve throttle response and fuel efficiency.



“This is a vehicle with innovation at its core – and that includes the turbo system,” says Alex Ismail, President of Global Passenger Vehicles at Honeywell Turbo Technologies. “We are delighted to be the turbo technology partner on such a landmark project – particularly as it confirms our position as a global force in gasoline turbocharging.”

The positioning of the twin fixed geometry turbos in the centre “Vee” of the V8 engine created considerable challenges for the Honeywell engineering team.

While the turbos benefit from water-cooled center housings, they are still subject to temperatures up to 1000°C at full engine load in the BMW X6 – and their position in the center of the “Vee” means there is minimal airflow available for the turbos, a situation made even more difficult by the need for heat shields to protect wiring.

*“This is a vehicle with innovation at its core – and that includes the turbo...”*

The effect is a significant increase in usual levels of thermo-mechanical stress, overcome in this instance through innovations in turbine design in the fixed geometry turbo and in the materials used to withstand the high operating temperatures.

“One of the biggest challenges for our engineers was to meet the durability targets of the project, given the harsh environment,” says Jean-Jaques Laissus, who leads Gasoline Platform at Honeywell Turbo Technologies. “However, an intensive test program at the Honeywell laboratory in Thaon-les-Vosges in France, involving close collaboration with BMW engineers, ensured we were able to deliver all the program objectives.”

## Spotlight On The V Engine

The tougher fuel efficiency standards, far from predicting the end for V8 engines, are ushering in a new generation of V8s.

Comparing the new BMW X6 gasoline engine to GM’s Honeywell-boosted Duramax 4.5-liter diesel V8, a February 17 article in the New York Times pointed out that both engines shared an important design innovation: “Each V8 had essentially been turned inside out.”

This is possible, noted the article, because “now that fuel injectors, which can be positioned directly at the individual cylinders, have replaced carburetors, it is possible to move the exhaust passages into the middle of the V.” The benefits of this innovation include simplified turbo installation and reduced loss of exhaust heat, so helping the catalytic converter reach operating temperature more quickly.

The reversed layout is also more compact, “making it easier to fit a V8 in the smaller vehicles that the new fuel economy rules will encourage,” noted the article.



+ FORD UNVEILS ECOBOOST TECHNOLOGY

+ HONEYWELL GASOLINE TURBO EXPERTISE BOOSTS LANDMARK PROJECT

# Downsizing The U.S.

Engine downsizing is big news in the U.S. – thanks to a new offering from Ford that's harnessing the power of direct injection with Honeywell's advanced gasoline turbo technology.

The EcoBoost engine range is creating a new dynamic in the equation between power, fuel economy and CO<sub>2</sub> output...and the result is one of the world's most powerful, yet fuel efficient gasoline-powered luxury sedans.

No wonder Ford's EcoBoost innovation is grabbing the headlines, since it's due to feature in half a million Ford, Lincoln and Mercury vehicles annually over the next five years.



This downsized gasoline range is providing a compelling proposition for US consumers.

"EcoBoost is meaningful because it can be applied across a wide variety

of engine types in a range of vehicles, from small cars to large trucks – and it's affordable," says Derrick Kuzak, Ford's Group Vice President of Global Product Development.

It is EcoBoost's combination of direct injection and Honeywell gasoline turbocharging that delivers impressive performance from the downsized 6-cylinder engines.

Ford will first introduce EcoBoost technology on the Lincoln MKS. The twin-turbo 3.5-liter V6 can deliver upwards of 340-plus lb-ft (461Nm) of torque across a wide engine range – 2,000 to 5,000 rpm – versus 270 to 310 lb-ft (366Nm to 420Nm) of torque for a conventional naturally aspirated 4.6-liter V8 over the same speed range. At the same time, this V6 gives customers an approximate 2 mpg improvement and emits up to 15 percent lower levels of CO<sub>2</sub>.

For Honeywell, this project was truly global in its scope – involving design engineers in France, application engineers in the U.S. and test engineers in China and the Czech Republic.

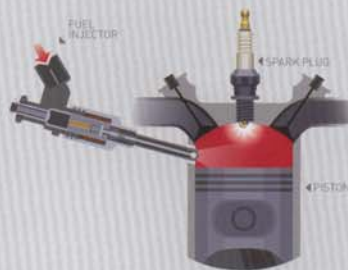
"From the outset, we worked extremely closely with Ford engineers to

*"Engine downsizing is big news in the U.S."*

optimize the performance of Honeywell's gasoline turbo technology for the EcoBoost project by leveraging the latest advances in turbine design and materials," says Jean-Jacques Laissus, who leads Gasoline Platform at Honeywell Turbo Technologies. "Durability was a key objective of the development activity and we were able to exploit Honeywell's global network of engineers to provide the technical know-how to fulfill the project requirements. The result is a very reliable gasoline turbo system for what is a landmark program."

## More With Less

Better fuel economy? Up to 20%. And more power. Simple fact: Even with advanced technologies, the majority of vehicles worldwide will be gasoline powered. That's millions. Ford Motor Company's new gas-turbo direct-injection engines can help. Here's how EcoBoost does more with less.



### Direct Injection

Highly pressurized fuel is injected directly into the combustion chamber of each cylinder rather than traditional mixing with the incoming air in the inlet port. Advantages include more precise fuel delivery for lower emissions, improved volumetric efficiency, better performance and fuel efficiency.

Text and images courtesy of Ford Motor Company





### Turbocharging

Energy from the engine's exhaust that would otherwise be wasted is utilized to rotate a turbine wheel, significantly increasing output per liter.



### Smaller Engine Block

With both direct injection and turbocharging in the equation, the EcoBoost 6-cylinder engine can produce like an 8. Go farther. Use less.



### Less Trips To The Pump

With EcoBoost's more efficient use of fuel, drivers will experience less trips to the gas pump, while not sacrificing performance.



- + RAPID GROWTH UNDERPINNED BY TECHNOLOGY PARTNERSHIPS
- + HONEYWELL BOOSTING NEXT GENERATION DIESEL ENGINES

# The “Yuchai Phenomenon”



**Yuchai has come a long way since its humble beginnings in 1951. What started as a local community enterprise is now a heavyweight player in China’s growing diesel engine industry as well as a major force in construction machinery, automobile parts, automotive chemicals, logistic machinery and special vehicles.**

With an annual production capacity of 600,000 diesel engines, Yuchai has emerged as a leading diesel engine maker in China, and is ranked among the top three transportation enterprises in the country. Yuchai Group is currently growing at more than 30 percent per year - creating what local media refer to as the “Yuchai Phenomenon.”



# menon”

“One of the key success factors is our focus on innovation and research,” said Mr. Liang Heping, Deputy General Manager overseeing Technology and R&D at Yuchai Machinery. “We have made significant technological advances in recent years, and Yuchai has now become a technology leader in medium and large diesel engines in China.”



There is every sign that Yuchai is aiming high. It was the first Chinese company that successfully developed diesel engines to meet the stringent Euro IV and Euro V standards, and it also developed the first Euro IV compliant engine powered by natural gas.

“That’s why Yuchai attaches great importance to forming strategic relations with suppliers who are also our technology partners,” says Mr. Liang, “and I’m happy to recall that when Yuchai introduced a Ford diesel engine assembly line from Brazil in 1992, it precipitated a collaboration between Yuchai and Honeywell that matured into a strategic partnership.”

Indeed, since Honeywell opened its wholly-owned turbo operation in Shanghai in 1995, Yuchai has remained its biggest customer. Today, Honeywell provides a diverse range of turbochargers that range from GT25 – GT42, supporting Yuchai’s determination to retain its position as the premium diesel engine provider in China.

“We were gratified to be recognized by Yuchai as a Core Supplier in 2007,” says Dinggui Gao, General Manager of Honeywell Turbo Technologies in China.

Of the several hundreds of suppliers to Yuchai, only a dozen top ones obtain the rare distinction of being called a Core Supplier.

“We appreciate the long-term approach adopted by Yuchai in working with its partners, and now the onus is upon us to redouble our efforts in speeding up localization, in providing quicker response and in delivering the most effective solutions for Yuchai,” says Dinggui Gao.

Looking forward, Honeywell engineers are already working closely with their counterparts at Yuchai on introducing Double Axle VNT™ and dual-stage turbocharging technologies for the next-generation diesel engines that will meet more stringent emissions standards in China.

“We are introducing Euro III compliant diesel engines for Beijing and Shanghai this year,” says Mr. Liang, “and we are expecting more advanced boosting technologies and more streamlined collaboration processes to add still further to the competitive advantage provided by our strategic partnership with Honeywell.”

“One of the key success factors is our focus on innovation and research.”



## Yuchai Growth: Key Timeline

**1951:** The company was first founded under the name “Yulin Quantang Industry Company.”

**1966:** 2105 diesel engine won first place in national industry quality contest.

**1980:** Successfully developed 6105Q diesel engine, and started to supply to Dongfeng Automobile.

**1989:** The production and sales passed 100 million yuan for the first time.

**1994:** China Yuchai International stock was officially listed in New York Stock Exchange, and the company successfully raised 75 million U.S. dollars.

**2005:** Yuchai group produced and sold more than 260,000 diesel engines.

**2007:** Yuchai was ranked 24th in China’s top 500 machinery enterprises.



# Media Talk

**For automotive OEMs, the ultimate challenge remains meeting tighter emissions and fuel efficiency requirements while delivering great performance. Turbocharging is increasingly a core enabling technology that helps OEMs grow in new markets, launch breakthrough engine platforms...and make headlines along the way.**



<<

"The EcoBoost engines use a combination of direct-injection and turbocharging to provide the power of a larger engine (Ford likens the turbo-four to a V6 and the turbo-six to a V8) while achieving 20-30 percent gains in fuel-economy, according to the automaker."

"Ford Showcases EcoBoost Engine Tech"

*Motor Trend, January 2008*

Caterpillar Inc. continues to see strong customer satisfaction for its ACERT heavy-duty diesel engines. "It is exciting that the state-of-the-art technology used in our engines is helping to reduce emissions without sacrificing performance and reliability,"

*George Taylor,*

*Director and General Manager,*

*Global On-Highway at Caterpillar*

"These (On-Board-Diagnostics emissions) certifications on Yuchai's Euro III and Euro IV diesel engines will provide Yuchai with an advantage compared with other Chinese diesel engine manufacturers."

"Yuchai's Export Engines Receive Key European Certification "

*PR Newswire, March 17, 2008*



^

"Isuzu Motors Japan has successfully sold their middle-weight 'F'-Series range to over 60 countries throughout the world. They are proven products and operator experience has given them a reputation for durability, reliability and economy."

"Isuzu Truck to Launch New Products at CV Show"

*Transportation News Network,*

*March 4, 2008*

<<

"According to BMW, the V8 engine making its world debut in the X6 is the most powerful engine ever used in a BMW X model. The X6 xDrive50i accelerates from 0-60 mph (0-97 km/h) in 5.3s."

"X6 Spearheads Sports Activity Coupe Segment"

*Automotive Engineering International,*

*March, 2008*





## Europe

### Czech Republic

#### Engineering – Turbochargers

Turanka 96/1236  
627 00 Brno-Slatina  
Tel: + 420 545 501 607  
Fax: + 420 515 501 801

### France

#### Manufacturing Plant & Worldwide PV Engineering – Turbochargers

Zone Inova 3000  
2 rue de l'Avenir  
88155 Thaon-les-Vosges  
Tel: + 33 3 29 81 30 00  
Fax: + 33 3 29 81 27 00

### Ireland

#### Foundry & Manufacturing Plant – Turbochargers

Unit 411 Industrial Estate  
Cork Road  
Waterford  
Tel: + 353 51 376411  
Fax: + 353 51 355352

### Italy

#### Manufacturing Plant – Turbochargers

Zone Industriale Saletti  
66040 Piazzano di Atessa (CH)  
Tel: + 39 0872 8911  
Fax: + 39 0872 889015

### Romania

#### Manufacturing Plant – Turbochargers

B-dul Luliu Maniu 244A  
Bucharest 6  
Cod Postal 77826  
Tel: + 40 21 408 5204  
Fax: + 40 21 408 5113

### United Kingdom

#### Engineering – Turbochargers

Priorswood Place  
West Pimbo  
Skelmersdale  
Lancashire WN8 9QB  
Tel: + 44 1695 714969  
Fax: + 44 1695 714990

#### Manufacturing Plant – Turbochargers

Stanley Green Estate  
Cheadle Hulme  
Cheadle  
Cheshire SK8 6QS  
Tel: + 44 161 486 3000  
Fax: + 44 161 486 3067

## Asia Pacific

### Australia

#### Sales Office

14 Alfred Road  
Chipping Norton  
New South Wales 2170  
Tel: + 61 2 9755 3311  
Fax: + 61 2 9724 7909

### China

#### Manufacturing Plant & Engineering – Turbochargers

No. 8, Niu Dun Road  
Zhang Jiang Hi-Tech Park  
Pudong New Area  
Shanghai 201203  
Tel: + 86 21 5080 1020  
Fax: + 86 21 5080 1030

### India

#### Manufacturing Plant & Engineering – Turbochargers

Plot No. 4A, Raisoni Industrial Estate  
Near Hinjewadi Phase II  
411057 Pune  
Tel: + 91 20 5652 4000  
Fax: + 91 20 5652 0229

### Japan

#### Sales Office

New Pier Takeshiba South Tower 20F,  
1-16-1 Kaigan, Minato-Ku,  
Tokyo, 105-0022  
Tel: + 81 3 6730 7070  
Fax: + 81 3 6730 7225

#### Manufacturing Plant & Engineering – Turbochargers

350-17 Kyoei, Kodama-Machi, Kodama-Gun,  
Saitama 367-0206  
Tel: + 81 495 72 4151  
Fax: + 81 495 72 4466

### South Korea

#### Sales Office

2F, Sambo B/D, 44-1  
Bampo-dong, Seocho-Ku  
Seoul 137-040  
Tel: + 82 2 595 1606  
Fax: + 82 2 595 7077

#### Manufacturing Plant – Turbochargers (Ansan)

3ma-819, Shiwaha Industrial Complex  
Jungwang-dong, Shiheung-city  
KyungKi 429-450  
Tel: + 82 31 497 0011  
Fax: + 82 31 497 0014

## Americas

### Brazil

#### Manufacturing Plant, Engineering & Sales – Turbochargers

Av. Julia Gaiolli, 212/250  
Bonsucesso, Guarulhos  
Sao Paulo 07250-270  
Tel: + 55 11 6487 3000  
Fax: + 55 11 6480 1113

### Mexico

#### Manufacturing Plant – Turbochargers

Calzada Lazaro Cardenas #2545, Col. Calles  
Mexicali B.C. C.P. 21396  
Tel: + 760 482 2166  
Fax: + 760 482 2177

#### Manufacturing Plant – Thermal Systems

Calle Ind. de la Electronica  
No. 44, Mexicali B.C. CP 21600  
Tel: + 760 355 3500  
Fax: + 760 355 3695

### United States

#### Worldwide CV Engineering – Turbochargers

3201 West Lomita Blvd  
Torrance, CA 90505-5064  
Tel: + 1 310 530 1981  
Fax: + 1 310 534 5941

#### North America Sales Office & Engineering – Turbochargers

47548 Halyard Drive  
Plymouth, MI 48170  
Tel: + 1 734 392 5500  
Fax: + 1 734 392 5511

## Headquarters

#### Worldwide Headquarters for Passenger and Commercial Vehicles

Avenue de la Gottaz 34-36  
P.O. Box 2202  
1110 Morges  
Switzerland  
Tel: + 41 21 644 2700  
Fax: + 41 21 644 2720

# Honeywell



**Worldwide Headquarters for Passenger  
and Commercial Vehicles**

Avenue de la Gottaz 34-36

P.O. Box 2202

1110 Morges

Switzerland

Tel: +41 21 644 2700

Fax: +41 21 644 2720

[www.honeywell.com/turbo](http://www.honeywell.com/turbo)

May 2008

Printed in USA

Honeywell Booster Magazine

© 2007 Honeywell International Inc.

**Honeywell**